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DATABASE DEVELOPMENT FOR THE DMSP EXPERIMENTS

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Processed data bases for the SSJ-4, SSM, SSJ-STAR and the SSIES experiments flown on-board the F6, F7, F8 and F9 DMSP vehicles have been created and/or maintained over the lifetimes of the four satellites. An historical overview of the DMSP project is presented. A description of each of the various payloads on-board the spacecrafts is provided. The data processing systems and associated computer software developed for each of the various experiments are described. Relevant calibration tables are provided. And, the formats of the individual data bases associated with each stage of the processing are described.

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TABLE OF CONTENTS

TABLE OF CONTENTS

PREFACE

This document describes data processing efforts required to generate data bases for researchers analyzing the results of various DMSP experiments for the Air Force.

Chapter 1 provides information on the DMSP project, in general, and is prepared primarily to provide a brief background for analysts new to the effort. The chapter also provides a brief description of each DMSP experiment and a general overview of the DMSP analysis system.

Chapter 2 provides an overview of the data processing procedures associated with the SSJ-4 experiment, a description of the format of the resulting processed data base and a brief review of the plotting capabilities developed to display the processed data.

Chapter 3 presents an overview of the SSM experiment data processing system.

Chapter 4 is comprised of an overview of the data processing associated with the SSJ-STAR experiment, a brief description of the processed data base format and a summary of the processed data plotting capabilities.

Chapter 5 describes in more detail the SSIES experiments and support electronics, provides an overview of the data processing procedures associated with the SSIES experiment and describes, in detail, the data reduction procedures used to generate SSIES data bases in geophysical and engineering units.

Appendix A contains detailed information on the DMSP agency tape format.

Appendix B presents detailed information on each DMSP experiment processed data base format.

Appendix C provides relevant calibration tables associated with the various DMSP experiments.

CHAPTER 1. DMSP OVERVIEW

1.1 HISTORICAL PERSPECTIVE

The Defense Meteorological Satellite Program (DMSP) has been in existence since the early 1960's. It has resulted in the successful launch and operation of several polar orbiting satellites designed primarily to provide tropospheric weather data through the use of the Operational Line Scan (OLS) system which images the earth in both the visible light and infra-red bands.

The DMSP vehicles have typically carried secondary sensors designed for the study of the ionosphere, stratosphere, troposphere and ocean surfaces. As the DMSP program has matured and the technology base has increased, the secondary sensors have become correspondingly more sophisticated. The early DMSP vehicles carried only one ionospheric secondary experiment consisting of a simply designed sensor for the measurement of the electrons which cause the aurora. The most recent vehicles have carried a particle spectrometer for the measurement of electron and ion fluxes; a triaxial fluxgate magnetometer; a radiation dosimeter; a thermal plasma monitor; and a scanning X-ray imager.

1.2 PURPOSE OF MISSION

The (OLS) system has been used to produce images of the earth's clouds and aurora. While the cloud images provide the necessary tropospheric data, the auroral images are an invaluable source of information on the auroral regions where increases in activity can cause serious disruptions in communications systems.

This instrumentation provides an excellent means of studying the high-latitude ionosphere which is connected to the magnetosphere. Thus, the study of magnetospheric processes can be accomplished by means of the secondary sensors flown on the DMSP vehicles. The GL particle spectrometer, thermal plasma monitor and fluxgate magnetometer provide an excellent combination of experiments to monitor the polar regions. Since the DMSP vehicles pass through the low altitude region of the Van Allen radiation belts, the dosimeter can be used to monitor these regions

in addition to studying the polar cap regions during solar flares.

The purpose of the SSIES experiment is to monitor the ionospheric thermal plasma, which affects communications and operations. The total ionospheric electron content (TEC) determines the phase delay of radio signals. The plasma density and scale height measured by the SSIES instrument, together with other data sources which describe the lower ionosphere, are used to determine TEC on an operational basis. Finally, the SSIES and SSJ/4 measurements can be combined to calculate the rate of joule heating of the lower ionosphere by currents driven by forces from the magnetosphere.

1.3 DESCRIPTION OF VEHICLES

Normally there are two DMSP vehicles in operation at any given time, each with a planned lifetime in orbit of three years. They are both in sun-synchronous orbits with one operating in the dawn-dusk meridian plane (0600: to 1800:) and the other in the meridian plane covering approximately 1030: to 2230:. The altitude of these vehicles is 835-840 kilometers (circular) which results in an orbital period of approximately 101 minutes. The vehicles are non-spinning with the vehicle +X axis pointing vertically to earth throughout the orbit. Momentum wheels located within the spacecraft are used to maintain the desired attitude.

1.4 DESCRIPTION OF EXPERIMENTS

The instruments on board the vehicles are the particle spectrometer (SSJ/4), the triaxial fluxgate magnetometer (SSM), the radiation dosimeter (SSJ-Star), and the thermal plasma monitors (SSIES). A brief description of each of these instruments is included in the succeeding sections of this chapter.

1.4.1 SSJ/4 PARTICLE SPECTROMETER

The SSJ/4 electron and ion spectrometer is the latest version of an instrument which has undergone a series of improvements over the detectors flown on previous DMSP

missions. The energy range from 30 eV to 30 keV is covered in 20 logarithmically spaced channels by the use of four cylindrical electrostatic analyzers (two for electrons and two for ions). Instrument apertures are mounted to look to local zenith. Electron and ion spectra are obtained approximately every second. The telemetry reads out compressed counts which when decompressed are convertible to differential number flux (and hence distribution function).

1.4.2 SSM TRIAXIAL FLUXGATE MAGNETOMETER

The SSM triaxial fluxgate magnetometer is mounted on the body of the DMSP vehicles and has successfully produced science quality magnetic field measurements. The sensor consists of three separate single axis fluxgate magnetometers which are mounted orthogonally on the spacecraft. Instrument design is the same as the triaxial system flown on the HILAT spacecraft. The instrument obtains 20 magnetic field vector measurements per second. These vector measurements are sent to the telemetry system as compressed counts which are convertible to total magnetic field intensity. Each axis of the triaxial system has a resolution of 12 nT.

1.4.3 SSJ-STAR RADIATION DOSIMETER

The instrument consists of four solid state detectors each of which is mounted behind aluminum shielding of different thicknesses. These shieldings result in thresholds of 1, 2.5, 5, and 10 Mev for electrons and 20, 35, 51 and 75 MeV for protons. Telemetry counts readout by each detector are proportional to energy deposition. By summing the energy depositions between fixed energy bands, the total dose for both low and high energy particles can be determined. Pulses per unit time are also recorded and are used to obtain measurements of integral electron and proton flux. Energy depositions above 40MeV are counted as nuclear star events.

1.4.4 SSIES THERMAL PLASMA MONITORS

The SSIES version of the thermal plasma monitors is an enhanced version of the SSIE instrument which was flown on

previous DMSP missions. The SSIES thermal plasma experiment consists of four instruments along with associated electronics. The four instruments are the planar ion driftmeter (IDM), a planar retarding potential analyzer (RPA), a spherical electron langmuir probe (LP) and a planar total ion density trap or scintillation meter (SM). The associated electronics includes a microprocessor used to control the instrument. The SSIES instrument measures ion and electron temperatures or scale heights, the bulk flow velocity of the thermal plasma, the plasma density and its fluctuations, the ratio of light ions (H+ and He+) to O+ and the differences between the drift velocities of the light ions and drift velocity of O+.

A more detailed description of the individual SSIES instruments and associated electronics can be found in a succeeding chapter.

1.5 DMSP ANALYSIS SYSTEM

The purpose of the DMSP analysis system was to provide each interested scientist with a readily accessible data base structured for his follow-on studies. Such a data base was created for each of the individual experiments, as described above.

1.5.1 FUNCTIONAL FLOW

The functional flow of data through the DMSP analysis system is described, as follows. Data from each DMSP satellite was stored first in an onboard tape recorder. Approximately once per orbit, the data was transferred to ground stations and relayed to the Air Force Global Weather Central, Offutt AFB, Nebraska. Data from the various sensors was analyzed for various operational needs. Once each day, the raw data from the ionospheric sensors was transferred to tape. The tapes were sent to GL for archiving of the data.

Each tape contained a series of files with each file having the data from a particular experiment (data from multiple spacecraft for the same experiment may have beeen on the same file). Each file consisted of a header record followed by multiple playbacks. Each playback contained an information record and multiple data records. All words were Univac 36-bit words; all physical records were 672, CDC 60-bit words in length. For a detailed description of the agency tape format refer to Appendix A.

Several such raw data tapes, received from GWC were concatenated onto a single tape according to a particular experiment, in question. The header records and end of files were deleted. A copy of each concatenated tape was made to secure a backup should a tape become unreadable.

1.5.2 DATA BASE REFORMATTING

Since incompatibilities existed between computer systems facilities at GWC and GL, a reformatting of the raw flight tapes was required in order to put the data structure into a form which was readily accepted for further processing at the GL central computer.

Also, in general, data for a particular day overlapped files and probably overlapped tapes. The time sequence from one playback to another was random, and the order within a playback was probably in reverse chronological order. Data may have simply been missing or repeated a number of times.

The reformat routines were designed to unpack the raw tape, choose data from a designated satellite, edit bad frames, account for telemetry dropout, chronologize the data from the playback passes, and create restructured files of CDC compatible data.

At this point, the SSJ-Star, the SSM and the SSJ/4 instrument data had been separated from the other experiment data. In the case of the SSIES experiment a second phase of computer processing was required to separate the experiments out into driftmeter data, scintillation meter data, retarding potential analyzer data, langmuir probe data, and microprocessor data.

1.5.3 DATA BASE INTERACTION

The complete data base was archived on digital tape. Summary displays consisting of averaged selected parameters in calibrated form were also produced. A logging procedure was developed which resulted in the creation of a log file containing information pertaining to the receipt of raw data, start and stop times, dates, and data base creation status. This log file was made accessible to the scientists so that they were aware of the status of any data base of interest. The data base was accessed by the summary display routines as well as the routines designed to structure data

bases for special studies. GL scientists could thus interact with the data base and any specially structured correlative data bases which contained data from previously flown vehicles. Authorized scientists from outside facilities could also interact with these data bases by means of networks such as the Space Physics Analysis Network (SPAN). GL scientists could also use SPAN to 'MAIL' data sets and display files to their outside agency counterparts.

1.5.4 SUBROUTINE LIBRARY

One of the important features of the DMSP analysis system was the development and implementation of a subroutine library to perform tasks where elements of commonality existed in requirements.

The use of this technique insured that no duplicity of code was developed. All routines utilized the library elements assuring that all common features were performed in exactly the same manner. This resulted in the development of modular routines which could easily be modified as requirements changed.

Examples of the types of functions which were effectively performed through the use of such subroutines included: interpolations for ephemeris and magnetic parameters; implementation of calibration procedures; common display requirements; corrected geomagnetic parameter determinations; packing and unpacking procedures; spectra integration for the determination of total number flux and total energy flux; and data retrieval.

1.5.5 CALIBRATION FILES

The calibration files used by each of the experiments was structured in ASCII. Thus, they were used directly on the central system where they were maintained, or were hyper-channeled to the VAX. In addition to the necessary calibration data, they contained a version number and dates of applicability. Analysis routines, accessing the calibration files, were coded to check dates and extract the appropriate calibration set. In cases where a calibration set was completely replaced, it was removed from the system and replaced by the new file. The removed file was, however, archived, should any questions arise at a later date.

1.5.6 SUMMARY AND DETAILED DISPLAYS

Summary and detailed displays were produced from the various experiment data bases.

The summary plots exhibited geophysical unit data averaged over common time intervals. These displays were useful in identifying events (unique occurrences on individual orbits) for study. Parameters displayed in summary form included total number flux, total energy flux, average energy, electron density and temperature, ion density, drift velocity, magnetic field measurements (or differences between measured and model fields). These various parameters were displayed as functions of time with geographic latitude and longitude as well as geomagnetic latitude, longitude and local time annotated.

The detailed displays were done in either raw or calibrated form. Data on these displays were at the full instrument rate. These displays were needed initially for data base verification. After data bases had been fully verified, the display routines were used for event studies where a detailed analysis of full rate was necessary in order to understand the phenomena being studied.

CHAPTER 2. SSJ/4 PROCESSING

2.1 SSJ/4 PROCESSING OVERVIEW

The telemetry for the SSJ/4 particle spectrometer consisted of compressed electron and ion values which were convertible to counts and then to flux. The natural structuring for such spectrometers was to arrange the data by spectra. Electron and ion spectra structure consisted of decompressed values arranged from lowest to highest energy. Implementation of the calibration data allowed for the direct computation of spectra in terms of number flux or distribution function. Further, spectra integration was easily performed resulting in total number flux, total energy flux and total energy. Thus, the SSJ/4 data base records consist of Universal Time (UT), ephemeris and magnetic parameters, and the structured electron and ion spectra. The data base records were independent of calibration data which changed over the lifetime of the flight as a result of upgraded calibrations. Refer to Table I in Appendix C.

2.2 SSJ/4 PROCESSED DATA BASE FORMAT

There are 3648 CDC (60-bit) words per record. These records contain exactly 10 minutes of flight data plus 8 spare (vacant) words. Each one minute block consists of 364 CDC words. In the event that less than 60 seconds of data was present on the GWC tape for any minute (due to telemetry dropout or other reasons) the missing seconds were zero filled at the end of the one minute block (i.e. following all of the normal data for the one minute interval). The last 8 words of every record are vacant (zero fill). For a detailed description of the SSJ/4 data base format refer to Appendix B.

2.3 SSJ/4 PLOTTING PROCESSED DATA

Programs were developed which accessed the SSJ/4 processed data base to plot selected parameters on microfiche. The programs generated routine survey plots for both ions and electron data. These plots exhibited total number flux, total energy flux and average

energy as functions of time with geographic latitude and longitude as well as geomagnetic latitude, longitude and local time annotated. These displays were useful in identifying events (unique occurrances on individual orbits) for study.

The plotting programs were run in interactive mode and were menu driven. The plot programs had options to display the data on paper and to display the averaged raw data in more detail for shorter periods of time. Data on these displays were at the full instrument rate. These displays were needed initially for data base verification. After data bases had been fully verified, the plot routines were used for event studies where detailed analysis at full rate were necessary to to understand the phenomenon being studied.

CHAPTER 3. SSM PROCESSING

3.1 SSM PROCESSING OVERVIEW

Telemetry data for the SSM consisted of a series of count values representing B and delta B measurements. For each of the axes, the delta B values were first converted to B-field measurements in counts. The SSM record structure consisted of UT, ephemeris/magnetic parameters, and the triaxial B-field measurements in counts for a natural time spacing such as one second.

The retention of the B-field data in counts allowed for calibration modifications in the conversion to nT. In addition, due to the fact that the magnetometer was body-mounted, algorithms were developed to correct for anomalous outputs. The B-field data in counts was the base set of units from which the algorithms were developed.

Values missing due to telemetry dropout within the natural time spacing were 1 filled; no filled values were inserted whenever dropout occurred over a full one second interval.

This data base design allowed for the direct correlation of measured field data with a model magnetic field such as IGRF. The subtraction of measured from model data was used in the detection of magnetic fields induced by electric currents.

CHAPTER 4. SSJ-STAR PROCESSING

4.1 SSJ-STAR PROCESSING OVERVIEW

The geophysical unit parameter list for the radiation dosimeter consisted of accumulated electron and proton dose; integral proton and electron flux; and star flux. The dose counters were designed to roll-over (return to zero) whenever the maximum counts which could be held by the accumulators had been attained. Thus, conversion of data from counts to geophysical units was most easily accomplished by taking the data in chronological order. The data structure for this experiment consisted of UT, ephemeris/magnetic parameters, and decompressed counts from detector readouts in a natural blocking of electrons electrons and protons for each of the four hemispherical aluminum shields or domes.

4.2 SSJ-STAR PROCESSED DATA BASE FORMAT

There are less than or equal to 4000 CDC (60-bit) words per record. Each record contains successive blocks of data (less than or equal to 64 seconds in duration) containing ephemeris information followed by less than or equal to 64 data words. For a detailed description of the SSJ-STAR data base format refer to Appendix B.

4.3 PLOTTING PROCESSED DATA

Programs have been developed which access the SSJ-STAR processed data base to plot the processed data on microfiche. The programs generate routine survey plots of the FLUX counts and DOSE data averaged over 64 seconds as a function of time and selected ephemeris parameters.

The plotting programs can be run in an interactive mode. The program is menu driven and can display data in more detail for shorter time periods. The plotting program includes options to plot, list or store numerous other selected combinations of dosimeter parameters

CHAPTER 5. SSIES PROCESSING

5.1 OVERVIEW OF SSIES EXPERIMENT

The SSIES experiment consists of four instruments and associated electronics. The four instruments are the planar ion driftmeter (IDM), a planar retarding potential analyzer (RPA), a spherical electron langmuir probe (LP) and a planar total ion density trap or scintillation meter (SM). The associated electronics includes a microprocessor used to control the instrument.

5.1.1 DRIFTMETER

The driftmeter is similar to one flown on HILAT. In its 'normal' mode, every other measurement represents the ratio of ion current flowing to the left and right halves of the sensor. The alternating measurements represent the ratio of ion current flowing to the top and bottom halves of the sensor. Unlike the HILAT driftmeter, this sensor has only one range. Thus, the ratio is converted into a flow speed of the ions in the horizontal (left to right) and vertical (top to bottom) direction by a simple trigonometric formula. This instrument has two operating modes, normal mode and H+ mode. Normal mode is intended to measure the average drift velocity of all ion species. The H+ mode, experimental in nature and, therefore, not used often, is intended to separate the measurement of the drift velocities of lighter ions, H+ and He+, from the total ion drift velocity which is dominated by O+.

The instrument makes measurements of the plasma's bulk velocity and, hence, the convection electric field. The sensor measures the two components of the plasma drift velocity along two axes perpendicular to the spacecraft's velocity vector.

5.1.2 SCINTILLATION METER

The scintillation meter or duct meter is similar to an RPA sensor that never retards ions. In earlier versions of this DMSP sensor, the RPA would dwell at zero voltage for 52 seconds and sweep its voltage for 12 seconds. These two modes have been made into two separate sensors. The scintillation meter now has five ranges and can change ranges at any time.

The scintillation meter measures total ion density and variations in the plasma density over scale lengths from 1 METER to 100 km. This sensor is a simple ion trap (Faraday cup) with no retarding voltage

5.1.3 ION RETARDING POTENTIAL ANALYZER

The ion retarding potential analyzer data is processed to determine the temperatures, masses and densities of the different ion species present, their velocities parallel to the spacecraft's direction of motion and the spacecraft potential. The RPA measures the total flux of ions as a function of a voltage placed upon a screen within the sensor. The 'normal' mode for the RPA sensor is for that voltage to vary from a zero level to a level that repels all thermal ions in four seconds. When all ions are repelled, no current will be measured. The current collected vs voltage level data is fitted to a theoretical curve.

5.1.4 ELECTRON SENSOR (LANGMUIR PROBE)

The electron sensor is a conducting sphere surrounded by a spherical grid. As the voltage applied to the grid changes, the sphere collects the resulting current. Data from the sensor is used to determine the electron temperature and density and the spacecraft potential.

The sensor measures the total flux of electrons as a function of a voltage placed upon the sensor. The 'normal' mode for the sensor is for that voltage to vary from a level that accelerates thermal electrons to a voltage that repels all thermal electrons in four seconds. At some level, all thermal electrons will be repelled and a background current of photoelectrons and other electrons will be measured. The processing consists of finding the accelerating and repelling portions of current collected vs. voltage levels data and fitting the two regions to straight lines.

5.1.5 MICROPROCESSOR

Although not an SSIES sensor, per se, the microprocessor is used to control the SSIES instrument. The microprocessor performs on-board data reduction including calculation of the plasma potential. The instrument does on-board analysis of RPA and electron sensor data.

The sensor is also used to collect data similar to that going into the data stream and to calculate answers similar to the calculations to be done on the ground. Thus, the sensor calculates ion densities and temperatures and, if two ion species are present, downrange drift velocity and spacecraft potential. The processed answers in the data stream are multiplied by constants and saved for future comparisons with the answers from the ground processed answers.

5.2 OVERVIEW OF SSIES PROCESSING

5.2.1 PHASE I (ARCHIVE OF RAW DATA)

Data from each DMSP satellite is stored first in an onboard tape recorder. Approximately once per orbit, the data are transferred to ground stations and relayed to the Air Force Global Weather Central, Offutt AFB, Nebraska. Data from the various sensors are analyzed for various operational needs. Once each day, the raw data from the ionospheric sensors are transferred to tape. The tapes are sent to GL for archiving of the data.

The SSIES Phase I database package has several major programs and an interactive program. Since these programs must be run in batch mode, the interactive program provides an interface between the user and the program. The interactive program has four options, which are the four steps towards creating the SSIES database.

The first option concatenates several raw data tapes, that are received from Air Force Global Weather Central (AFGWC), onto a single tape. The SSIES raw data files (IESPREPFILE) are found on each raw data tape and copied to an output tape. The header records and end of files are deleted.

The second option makes a copy of a concatenated tape. This is done so that the database tapes have a secure backup should a tape become unreadable.

The third option edits data from concatenated tapes. It checks for the correct satellite, valid data, and valid times. The data must fall in the user-specified day range (1-5,6-10,11-15,etc.) for a specific year and month. A five day (six days when processing at the end of a 31 day month) range was chosen because the amount of temporary disk storage used to sort the data into the correct time order was becoming excessive. A data base tape is created for the first ten, middle ten, and last ten or eleven days for each month of data.

The fourth option creates a batch file that allows the user to make a copy of a data base tape onto a multifile tape. This option is not used.

5.2.2 PHASE II (PROCESSING OF RAW DATA INTO GEOPHYSICAL PARAMETERS)

The SSIES Phase II database package accesses the Phase I

SSIES database in order to unpack a specified interval of data. Then, it either runs the data processing routines to produce a scientific database of ionospheric plasma parameters or simply dumps the data to a file for future raw data plotting or printing for debugging.

Packed binary files with ephemeris are generated separately for the driftmeter, scintillation meter, retarding potential analyzer, langmuir probe, and microprocessor.

There is an option to process or to not process the RPA data. A particular RPA subroutine package must be chosen to process the RPA data.

Data is processed in one minute intervals with a variable number of minutes per output record depending upon the experiment. All variables are converted to positive integers and are stored in 8, 16, 24, or 32 bits. If variables are not within an expected range, the associated bits are one filled. Data is separated by day; multiple days may be executed.

5.2.3 PHASE III (PLOTTING PROCESSED DATA)

Programs have been developed which access the Phase II database to plot the processed data on microfiche. The programs generate routine survey plots of the following quantities as functions of time. From the driftmeter, the program plots the components of the drift velocity perpendicular to the satellite's velocity, from the scintillation meter, total ion density and power from the various filters, and from the langmuir probe, electron temperature and density and spacecraft potential. Also plotted are the measured aperture potential with respect to spacecraft ground and the results of the on-board microprocessor's data analysis.

The plotting program can be run in an interactive mode. The program is menu driven and can display data in more detail for short time periods. Although RPA analysis is not run on a routine basis because of the cpu time required, the RPA data is processed for case studies. The plotting program includes an option to plot total ion density, density of the different ion species, ion temperature aperture potential, spacecraft potential and downrange drift velocity.

Additional computer programs to calculate electric fields from the driftmeter and RPA data, and integrated potential along the satellite track from driftmeter data are in the development stage.

5.3 SSIES PROCESSING SYSTEMS

5.3.1 PHASE I (ACCESS AND UNPACK DATA FROM AGENCY TAPES)

The SSIES Phase I data base package begins by concatenating SSIES raw data from several tapes, that contain data from various DMSP experiments. The header records and end of files that separate one experiment from another on the agency tapes are deleted.

The concatenated tapes contain records consisting of a bit stream of Univac 36-bit words that must be appropriately unpacked according to data type and stored into 60-bit words on the Central Data Corporation Cyber 180 using the NOS operating system. These records contain data from multiple time intervals, referred to as playbacks, comprised of information records followed by data records.

5.3.2 PHASE I (EDIT DATA ACCORDING TO TIME CONSTRAINTS)

Because the time order from one playback to another is random and the order within a playback is usually in reverse chronological order, the times are quality checked. If the time interval or the satellite identification on the information record is not what the user wants, the data for this playback is excluded.

The ephemeris times, associated with each data record, are also quality checked. If the year or day is not within the requested range or the time is less than zero or greater than 86400 seconds, the data for this record is eliminated.

If the sync value for a particular second of telemetry data is incorrect, the time for this second is set to 99999999 and the data is subsequently eliminated. An attempt is made to assign the proper day number with total seconds. Each data record is divided and stored into a file of ephemeris data and a file of telemetry data channels. A system sort routine is then used to put the file of ephemeris data into chronological order.

As the data on the concatenated tapes is quality checked, selected ephemeris parameters for the first, last, and every thirtieth record within an accepted playback interval are printed. For each concatenated tape processed, a printout of which playbacks have been rejected and which have been accepted is generated.

5.3.3 PHASE I (EDIT FILE OF TELEMETRY DATA)

The file of telemetry data must be further edited. Due to digitization problems, times associated with a telemetry stream may be duplicated, missing, or incorrect.

Time values greater than or equal to 86400 may mean that the satellite clock has not been properly reset. If, after subtracting 86400 from these times, the time for a second still exceeds 86400, the data associated with this second is eliminated. If a time value is encountered that is not near its neighbors, this second of data is eliminated. If three time values that are the same are encountered, an attempt is made to shift a value into a vacant slot. If an appropriate vacant slot cannot be found, this second of data is eliminated.

This editing procedure only uses eleven consecutive values. Because there may be an overlap of several minutes of data between playbacks, these duplicated times have not been eliminated.

A disk file consisting of day, time, and 120, 9-bit words of telemetry data is created. Every hundredth set of sixty consecutive day and time values is printed as this file is generated. A system sort routine is used to put this telemetry file into chronological order. Duplicate times between playbacks remain.

5.3.4 PHASE I (INTERPOLATE EPHEMERIS AT EVEN MINUTE)

Ephemeris values are interpolated at each even minute contained within the time interval covered by the ephemeris data. The time at the even minute must be bounded by unequal times.

A linear interpolation is performed on the ephemeris parameters: geodetic latitude and longitude. The interpolation is accomplished by constructing two successive unit position vectors surrounding the time, in question, and linearly interpolating between each of the three respective components of these two vectors. The new latitude and longitude values are then derived from the components of the normalized resultant position vector.

Linear interpolation is performed on the altitude at the beginning and end of the interval in question, each of the components of the position vector in the earth centered inertial system of base vectors, and the angle on the

orbital plane between the ascending node and satellite location.

5.3.5 PHASE I (MERGE AND PACK OUTPUT)

The file of ephemeris data that has been interpolated at each even minute is merged with the file of telemetry channel data that has been edited. If there is no channel data for a particular minute, the ephemeris for this minute is deleted. A time bit map word is constructed so that, when a bit is set, data exists for a particular second following the even minute.

Examples:

77777777777777777777B (All seconds exist)
00777777777777777777B (First six seconds missing)

If data for a particular second is missing, the telemetry stream is packed continuously with zero fill at the end of existing data to ensure that the same number of words will be used for each minute. Duplicate telemetry seconds of data are eliminated. The number of seconds that are rejected is listed on the output.

At each even minute corrected geomagnetic latitude and longitude at the sub-satellite point are calculated using subroutine CGLALO. Using subroutines MGFLD2, LINTRA, and CONVERT geographic latitude (CLAT) and longitude (CLON) at 110km, invariant latitude, Bx, By and Bz are calculated. Using CLAT and CLON the geomagnetic latitude and longitude at 110km is calculated using subroutine CGLALO. The magnetic local time at 110km and the geographic latitude and longitude at the subsolar point are calculated using subroutine MAGTIM.

The ephemeris values and telemetry data are packed into 60-bit words according to the format described in Appendix B. Thus, at the end of the Phase I level of processing a database has been created which contains the data in chronological order to be used as input in the Phase II processing.

5.3.6 PHASE II (COMPUTE GEOPHYSICAL QUANTITIES)

Program Phase II reads in time ordered, raw SSIES data from Phase I. The user requests a time interval beginning at

a particular day and time and ending at a particular day and time. Within this time interval data is unpacked.

If meaningful physical quantities are to be produced, the user specifies whether or not to process the RPA experiment and to turn on the RPA debugging prints. If an RPA database is to be created, the user specifies the name of the RPA subroutine package to be loaded with the program as each package takes up a considerable amount of space. These RPA options are included because the data is questionable, at times, and relatively time consuming to process on the computer.

Each physical record of data contains three logical records that represent one minute of data each. Each minute of data contains seven header words and eighteen words per second of data. Each minute is unpacked separately. The telemetry stream of 120, 9-bit words is unpacked and stored into arrays as exhibited in Table 1 for each second of existing data. The variable, N, in Table 1 refers to the particular second within a minute of data. Using the time bit map word, if a second is missing the arrays are padded with a garbage value. If the first bit of the first housekeeping word, cycle value, is the same for two successive seconds, the arrays associated with the latter second are filled with a garbage value.

If the data is not to be processed into physical quantities, the unpacked data stream is dumped to a file for future raw data plotting or printing. Six records of ephemeris values and unpacked instrument readings are generated for each minute.

If a database is to be created for each experiment, the next minute is read in to determine the cycle value, if the data starts at second zero, and if the data for the first second exists. If time and the cycle count are increasing sequentially and the housekeeping flags indicate the satellite is in the proper mode, the data for this second is processed. If there is a time gap the data for the following second is eliminated.

5.3.7 PHASE II (PACK ACCORDING TO EXPERIMENT)

The data is processed in intervals of one minute and stored separately according to experiment on different disk files. The physical record size and the number of minutes of data within a record for each experiment are fixed. If there

is no data for an entire minute subsequent data is packed continuously without filling for the missing minute.

For each experiment, each set of data for each minute begins at specified word and bit locations to ensure that each minute of data has the same length of bytes. Zero fill is used to maintain the proper length. (See Appendix B)

Each minute of data contains the satellite and data file identification, ephemeris parameters, and data values associated with the experiment. Since the data is packed within 60-bit words, all values are stored as positive integers. If the value of a data word could be negative, a bias is added to the value to ensure that it is always stored as a positive. This bias value is noted in parentheses in the description of each variable in Appendix B. If a value exceeds its range the bytes associated with the value are one filled.

When the end of the time range or an end of file is reached the remaining minutes, if any, stored in core are written to the appropriate disk file. The disk files are rewound and copied to tape in the order described in Appendix B. A message is written to indicate disk files have been successfully copied to tape. If more days are to be processed, the program reads the next record of data. If a double end of file has been reached a message is printed indicating that Phase II has finished executing.

TABLE 1: PHASE II PROGRAM VARIABLE NAMES

Each word = 9 bits
120 words = 1 second of raw data

word 1	2	3	4	5	6	7	8	9	10
HKP 1,N	SCIN 1,N	RPA 1,N	ELEC 1,N	SWPMON 1,N	DRIFT 1,N	SCIN 2,N	RPA 2,N	ELEC 2,N	SMFILT 1,N
11	12	13	14	15	16	17	18	19	20
SMFILT 2,N	SCIN 3,N	RPA 3,N	ELEC 3,N	SWPMON 2,N	DRIFT 2,N	SCIN 4,N	RPA 4,N	ELEC 4,N	SMFILT 3,N
21	22	23	24	25	26	27	28	29	30
SMFILT 4,N	SCIN 5,N	RPA 5,N	ELEC 5,N	SWPMON 3,N	DRIFT 3,N	SCIN 6,N	RPA 6,N	ELEC 6,N	SMFILT 5,N
31	32	33	34	35	36	37	38	39	40
SMFILT 6,N	SCIN 7,N	RPA 7,N	ELEC 7,N	SWPMON 4,N	DRIFT 4,N	SCIN 8,N	RPA 8,N	ELEC 8,N	SMFILT 7,N
41	42	43	44	45	46	47	48	49	50
SMFILT 8,N	SCIN 9,N	RPA 9,N	ELEC 9,N	SWPMON 5,N	DRIFT 5,N	SCIN 10,N	RPA 10,N	ELEC 10,N	SMFILT 9,N
51	52	53	54	55	56	57	58	59	60
SMFILT 10,N	SCIN 11,N	RPA 11,N	ELEC 11,N	SWPMON 6,N	DRIFT 6,N	SCIN 12,N	RPA 12,N	ELEC 12,N	HKP 2,N DM LLB

TABLE 1: PHASE II PROGRAM VARIABLE NAMES (continued)

WD 61	62	63	64	65	66	67	68	69	70
HKP 3,N	SCIN 13,N	RPA 13,N	ELEC 13,N	SWPMON 7,N	DRIFT 7,N	SCIN 14,N	RPA 14,N	ELEC 14,N	HKP 4,N
71	72	73	74	75	76	77	78	79	80
HKP 5,N	SCIN 15,N	RPA 15,N	ELEC 15,N	SWPMON 8,N	DRIFT 8,N	SCIN 16,N	RPA 16,N	ELEC 16,N	HKP 6,N
81	82	83	84	85	86	87	88	89	90
HKP 7,N	SCIN 17,N	RPA 17,N	ELEC 17,N	SWPMON 9,N	DRIFT 9,N	SCIN 18,N	RPA 18,N	ELEC 18,N	HKP 8,N
91	92	93	94	95	96	97	98	99	100
HKP 9,N	SCIN 19,N	RPA 19,N	ELEC 19,N	SWPMON 10,N	DRIFT 10,N	SCIN 20,N	RPA 20,N	ELEC 20,N	HKP 10,N
101	102	103	104	105	106	107	108	109	110
HKP 11,N	SCIN 21,N	RPA 21,N	ELEC 21,N	SWPMON 11,N	DRIFT 11,N	SCIN 22,N	RPA 22,N	ELEC 22,N	HKP 12,N
111	112	113	114	115	116	117	118	119	120
HKP 13,N	SCIN 23,N	RPA 23,N	ELEC 23,N	SWPMON 12,N	DRIFT 12,N	SCIN 24,N	RPA 24,N	ELEC 24,N	HKP 14,N

HKP = Housekeeping and microprocessor data
SCIN = Scintillation meter data
RPA = Retarding Potential Analyzer data
ELEC = Electron Sensor data
SWPMON = Applied voltages on swept grids of RPA and ELEC
DRIFT = Ion Driftmeter data

APPENDIX A - AGENCY TAPE FORMAT

Data tapes are produced at AFGWC, Omaha, Nebraska.

Each tape contains a series of files with each file having the data from a particular experiment (data from multiple spacecraft for the same experiment may be on the same file). Each file consists of a header record followed by multiple playbacks. Each playback contains an information record and multiple data records. The formats for these record types follow. All words are Univac 36-bit words; all physical records are 672, CDC 60-bit words in length.

In general, data for a particular day will overlap files and probably overlap tapes. The time order from one playback to another is random, and the order within a playback is probably in reverse chronological order. Data may simply be missing or repeated a number of times.

Header Record:

The header record contains 20 Univac 36-bit words of information for the first playback followed by eight zero filled words. The succeeding 28 words contain information for the second playback, etc.. These words are followed by zero filled words to bring the record to the specified length. The word definitions are as follows:

Word No.	Bits	Description
1	1-36	Processing batch number (I)
2	1-36	Satellite ID (eg. WX9543) (A)
3	1-36	Playback rev number (I)
4	1-36	Nodal longitude x 10 (I)
5	1-36	Nodal Julian hour (I)
6	1-6	Nodal day (I)
	7-12	Nodal month (I)
	13-24	Nodal year (I)
	25-36	Nodal time - HHMM (eg. 2359) (I)
7	1-36	Beginning address (I)
8	1-36	Ending address + 1 (I)
9	1-36	Number of logical data records in playback (I)
10	1-12	Julian day of first record in playback (I)
	13-18	Filler
	19-24	Hour of first playback (I)
	25-30	Minute of first playback (I)
	31-36	Second of first playback (I)

11	1-12	Julian day of last playback (I)
	13-18	Filler
	19-24	Hour of last playback (I)
	25-30	Minute of last playback (I)
	31-36	Second of last playback (I)
12	1-36	Number of physical records in playback (I)
13	1-36	Number of playbacks (I)
14	1-36	Namel (A)
15	1-36	Namem Identifying (A)
16	1-36	Namer Experiment (A)
17	1-36	Playback rev number (I)
18	1-36	Frame count (I)
19	1-36	Number of time code discontinuities (I)
20	1-36	Tape physical record size (e.g.1120 words)(I)
21-28		Zero filled
29-56		Words 1-28 repeated for the next playback
57-84		" " " " " " "

Information for each playback within this file is stored in this header record. After the last word of information the remaining words are zero filled to bring the record to the specified length of 1120, 36-bit words.

Information Record:

The information record for each playback contains the same twenty-eight words as in the header record for that playback. The remaining words are zero filled to bring the record to the specified length.

Data Records:

Following the information record are the data records for this playback. Each data record has the ephemeris data for a one minute period followed by the telemetry data in 60 one second intervals, consisting of a sync word, time word, and telemetry data.

Ephemeris Data: All words are 36-bit Univac words.

Word No	Description
1	Latl geodetic - radians (R)
2	Longl - radians (R)

3	Alt1 - NM (I)
4	Julian day1 (I)
5	Time1 - Time of first readout on record-seconds (I)
6	Lat2 - As above for 60 seconds earlier (R)
7	Long2 - As above for 60 seconds earlier (R)
8	Alt2 - As above for 60 seconds earlier (R)
9	Julian day2 - As above for 60 seconds earlier (R)
10	Time2 - As above for 60 seconds earlier (R)
11	X1 Position (R)
12	Y1 Position (R)
13	Z1 Position (R)
14	X2 Position for 60 seconds earlier (R)
15	Y2 Position for 60 seconds earlier (R)
16	Z2 Position for 60 seconds earlier (R)
17	Lat1A x 10000 - Geodetic - radians (I)
18	Long1A x 10000 - radians (I)
19	Alt1A - NM (R)
20	Lat2A - As above for 60 seconds earlier (I)
21	Long2A - As above for 60 seconds earlier (I)
22	Alt2A - As above for 60 seconds earlier (R)
23	Sath angle 1 (R)
24	Sath angle 2 (R)
25	Dummy (I)
26	Dummy (I)
27	Dummy (I)
28	Dummy (I)
29-1120	Sixty sets of sync, time, and telemetry follow. (I) The time is in bits 10-36 of the second word. (Seconds is obtained by dividing the integer value by 1024.)

SSIES Experiment:

For the SSIES experiment, there are a total of 120, 9-bit words per second. Thus, data records require 28 + 60(30 + 2) = 1948 Univac words per minute. With a block size of 1120 words, GWC will require one physical record plus a portion of another record to store one minute of data. The first record will have a full 1120 word record of flight data; the second record will have 828 data words followed by 68 zero filled words. The second logical record begins at word 897 of the second physical record. Refer to Figure 1.

SSJ/4 Experiment:

For the SSJ/4 experiment, there are a total of 40, 9-bit words per second. Thus, data records require 28 + 60(12) = 748 Univac words per minute, followed by 36 zero filled words. GWC required less than one physical record to store one minute of data. Refer to Figure 2.

SSM Experiment:

For the SSM experiment, there are a total of 40, 9-bit words per second (360bps). Thus, data records require 28 + 60(12) = 748 Univac words per minute.

SSIES Logical/Physical Record Structure

```
R.N. 1    2     3     4     5     6     7     8     9     10
------ ----- ----- ----- ----- ----- ----- ----- ----- -----
                 |     |     |     |     | 156 |     |     |
                 |     |     | 380 |     |  +  |     |     |
                 | 604 |     |  +  |     |  68 |     |     |
        828      |  +  |     |  68 |     |words|     |     |
 1120    +   1120|  68 | 1120|words| 1120|-----| 1052| 1120|
36-bit   68 |words|words|words|-----|words|     |  +  |words|
words  words     |-----|     |     |     | 896 |  68 |     |
                 |     |     | 672 |     |words|words|     |
      |-----|    | 448 |     |words|     |     |     |     |
      | 224 |    |words|     |     |     |     |     |     |
      |words|    |     |     |     |     |     |     |     |
------ ----- ----- ----- ----- ----- ----- ----- ----- -----
```

R.N. = Physical record number.

Logical record no. 1 consists of 1120 words plus 828 words plus 68 zero filled words.

Logical record no. 2 consists of 224 words plus 1120 words plus 604 words plus 68 words. (etc.)

Logical record no. 5 ends evenly on the ninth record.

The sequence is repeated beginning at physical record no. 10.

Figure 1

SSJ/4 Logical/Physical Record Structure

```
R.N. 1     2     3     4     5     6     7
------ ----- ----- ----- ----- ----- -----
|      |     | 76  |     | 188 |     |     |
|      | 412 |  +  | 524 |  +  | 636 | 300 |
| 748  |  +  | 36  |  +  | 36  |  +  |  +  |
|  +   | 36  |words| 36  |words| 36  | 36  |
| 36   |words|-----|words|-----|words|words|
|words*|     |     |     |     |     |     |
|      |-----| 748 |-----| 748 |     |-----|
|------|     |  +  |     |  +  |     |     |
|      |     | 36  |     | 36  |-----| 748 |
| 336  | 672 |words| 560 |words|     |  +  |
|words |words|     |words|     | 448 | 36  |
|      |     |-----|     |-----|words|words|
|      |     | 224 |     | 112 |     |     |
|      |     |words|     |words|     |     |
------ ----- ----- ----- ----- ----- -----
```

* All words are 36-bit words.

R.N. = Physical record number.

All logical records contain 748 words + 36 zero fill words.

Logical record no. 1 consists of 748 words plus 36 zero filled words.

Logical record no. 2 = 336 words from physical record no. 1 plus 412 words and 36 zero fill words from physical record no. 2.

Logical record no. 10 ends evenly with physical record no. 7.

The sequence is repeated beginning at physical record no. 8.

Figure 2

APPENDIX B - EXPERIMENT DATABASE FORMATS

SSIES PHASE I DATABASE FORMAT - DMSP/F8/F9

There are 3264 words per physical record. Each record contains 3 minutes of data. For each minute there is ephemeris data and exactly 60 frames of telemetry data (one frame per second). Each minute of data requires 1087 (60-bit) CDC words. The three minutes of data are stored in words 1-3261. Word 3262 contains a code word to identify the spacecraft. The remaining two words are vacant (zero fill). The last record of data for a day is followed by an End of File. If the last record for a day does not contain three minutes of SSIES data, the day number following the last good set of data is set to 999 and the remainder of the record is zero filled.

Should data be missing due to telemetry dropout or other reasons, zero fill is used at the end of the good data. The use of zero fill guarantees that all one minute groups are the same size. A 60-bit mapping word is used to indicate whether or not data exists for a particular second for the associated minute of data. If bit 60 is set to 1, the data for the zero second exists; if bit 59 is set to 1, the data for the next second exists, etc..

All angles are in degrees and the altitude is in nautical miles. In the bit numbering sequence below, bit 60 is the most significant bit of a CDC word and bit 1 is the least significant bit.

CDC Word	Bits	Description
1	60-49	Geographic longitude(GLON)[X10]
	48-37	Geographic latitude(GLAT)[X10]
	36-31	Second(IS)
	30-25	Minute(IM)
	24-19	Hour(IH)
	18- 7	Day of year (JDAY)
	6- 1	Year (IYR) [Year=Year-50]
2	60-49	Geomagnetic latitude at 110 km (RMLAT)[X10]
	48-37	Geomagnetic longitude at satellite(GMLONST)[X10]
	36-25	Geomagnetic latitude at satellite(GMLATST)[X10]
	24-13	Geographic longitude at subsolar point(ALON)[X10]
	12- 1	Geographic latitude at subsolar point(DEC)[X10]

3	60-49	Alt. at beginning of ephem. minute(ALTBEG)-NMI
	48-37	Invariant latitude (RNVARLT)[X10]
	36-25	Geographic longitude at 110 km (CLON)[X10]
	24-13	Geographic latitude at 110 km (CLAT)[X10]
	12- 1	Geomagnetic longitude at 110 km (RMLON)[X10]
4	60-41	X coordinate of satellite in ECI (XECOS)[X10**5]
	40-23	Magnetic local time at 110 km (RMLT)-SEC
	22-11	Alt. at end of ephemeris minute (ALTEND) - NMI
	10- 1	Filler
5	60-41	BX in 10ths of gamma
	40-21	Z coordinate of satellite in ECI (ZECOS)[X10**5]
	20- 1	Y coordinate of satellite in ECI (YECOS)[X10**5]
6	60-41	BZ in 10ths of gamma
	40-21	BY in 10ths of gamma
	20- 1	Filler
7	60- 1	Mapping word(IMAP)
8-1087		60 groups of 18 words (one group per sec.)
1088-2174		Repeat order of words 1-1087 for next minute
2175-3261		Repeat order of words 1-1087 for next minute
3262	60- 1	Satellite id (integer; 8 for satellite F8, 9 for satellite F9)
3263-3264		Vacant (zero fill)

NOTES:

1. The 18 CDC words containing the telemetry data actually consist of 120 9-bit words (since the SSIES telemetry rate is 1080 bps).

2. For XECOS, YECOS and ZECOS, if the MSB of the 20-bit word is set to 1, the value is negative. To obtain the proper negative number subtract 1048575 from the value stored in the 20 bits.

3. For BX, BY and BZ, if the MSB of the 20-bit word is set to 1, the value is negative. Use the same procedure described in 2. above to get the proper value.

4. For all latitude values, if the MSB of the 12-bit word is set to 1, the number is negative. To obtain the proper negative number, subtract 4095 from the value stored in the 12-bit word.

SSIES PHASE II DATABASE FORMAT

The files of processed values for one day of SSIES data have the following organization :

FILE	RECORD	BITS
Driftmeter (DM)	<packed data w/ephemeris - 10 mins>	(3056
data file	<packed data w/ephemeris - 10 mins>	60-bit
	.	words)
	.	
	.	
last rec. of day	<packed data w/ephemeris - 10 mins or less>	
	<EOF>	
Scintillation	<packed data w/ephemeris - 10 mins>	(2656
meter (SM) data	<packed data w/ephemeris - 10 mins>	60-bit
file	.	words)
	.	
	.	
last rec. of day	<packed data w/ephemeris - 10 mins or less>	
	<EOF>	
Ion Retarding	<packed data w/ephemeris - 20 mins>	(1312
Potential Analy-	<packed data w/ephemeris - 20 mins>	60-bit
zer (RPATEX,	.	words)
RPAEWA, etc.)	.	
data file *	.	
last rec. of day	<packed data w/ephemeris - 20 mins or less>	
	<EOF>	
Electron Langmuir	<packed data w/ephemeris - 20 mins>	(992
Probe (ELEC) data	<packed data w/ephemeris - 20 mins>	60-bit
file	.	words)
	.	
	.	
last rec. of day	<packed data w/ephemeris - 20 mins or less>	
	<EOF>	
Microprocessor	<packed data w/ephemeris - 20 mins>	(1312
(MICRO) data file	<packed data w/ephemeris - 20 mins>	60-bit
	.	words)
	.	
	.	
last rec. of day	<packed data w/ephemeris - 20 mins or less>	
	<EOF>	
DM data file for	..	
next day	..	
	<EOF>	

```
SM data file for   ..
next day           ..
                  <EOF>
RPA data file for  ..
next day *         ..
                  <EOF>
ELEC data file     ..
for next day       ..
                  <EOF>
Microprocessor     ..
file for next day  ..
                  <EOF>
(Repeated for as   ..
many days of data  ..
as the tape will   ..
hold)              ..
                   ..
                  <EOI>
```

* NOTE:

Since the RPA processing is very time consuming, it is anticipated that the RPA data files will be missing for most (and perhaps all) days of routine processing. In such a case, the output tape has 4 files per day instead of 5 files per day.

****

SSIES PHASE II OUTPUT RECORD FORMAT

Each record consists of a series of ephemeris words packed into bytes followed by a series of data words for 1 minute of data packed into bytes. The packed ephemeris and data words for the 2nd, 3rd, ... , Nth minute follow. Bytes from the end of the Nth minute of data to the end of the physical record are dummy filled.

Packing consists of converting all variables into integers and placing 8 bit (1 byte) or 16 bits (2 bytes) or 24 bits (3 bytes) or 32 bits (4 bytes) into an output array. The tables below show: 1) the names of the variables output, 2) the definition of the variables output, 3) the internal type of the variable, 4) the expected range of the variable, and 5) the number of bytes used to store the variable in the output array. The expected range also indicates the number of significant numbers being packed. For example, an expected range of '0.0 - 180.0' indicates that one significant digit passed the decimal point is packed; and an expected range of '0.-18D.' indicates that one significant digit before the decimal point is dropped before packing.

Variables not within the expected range are set to FF (Hex) or FFFF (Hex) or FFFFFF (Hex) or FFFFFFFF (Hex). Variables which are internally represented as a character string are converted into a set of 8-bit bytes; each byte represents one character. 41 (Hex) to 5A (Hex) will represent the characters A to Z; 30 (Hex) to 39 (Hex) represent the character 0, 1, ..., 9; 20 (Hex) represents the blank or space character.

****

EPHEMERIS GROUP OF VARIABLES

INTERNAL NAME OF VARIABLE	DESCRIPTION (BIAS)	INTERNAL TYPE	EXPECTED RANGE	NO OF BYTES
-----	Spacecraft ID	CHAR	F8 - F20	5
-----	Data File ID (Driftmeter= 'DM ' Scintillation Meter = 'SM ' Ion RPA = 'RPATEX' [Univ of Texas, Dallas version] or 'RPAEWA' [Ewa Lewin's version] or 'RPADWF' [Dan Weimer's fast version] or 'RPADWS' [Dan Weimer's slow (SIMPLEX) version])	CHAR	----	6
year	year [Year -1950]	I	37 - 99	2
jday	julian date	I	1 - 366	2
hour	hour of day - hr	I	0 - 24	1
min	minute of hour - min	I	0 - 59	1
geolat	geographic latitude - deg (+90.)	F	0. - 180.0	2
geolong	geographic longitude - deg	F	0. - 360.0	2
maglat	geomagnetic latitude at sub-satellite pt. - deg (+90.)	F	0. - 180.0	2
mlt	magnetic local time at 110km field line intercept - hr	F	0. - 24.0	2
maglong	geomagnetic longitude at sub-satellite pt. - deg	F	0. - 360.0	2
glatsol	geographic latitude of sub-solar pt - deg (+90.)	F	0. - 180.0	2
glonsol	geographic longitude of sub-solar pt - deg	F	0. - 360.0	2
glat110	geographic latitude at 110 km - deg (+90.)	F	0. - 180.0	2
glon110	geographic longitude at 110 km - deg	F	0. - 360.0	2
mlat110	geomagnetic latitude at 110 km - deg (+90.)	F	0. - 180.0	2
mlon110	geomagnetic longitude at 110 km - deg	F	0. - 360.0	2
invlat	invariant latitude - deg	F	0. - 90.0	2
alt1	altitude at the start of minute - n.mi.	I	400 - 500	2
alt2	altitude at the end of minute - n.mi.	I	400 - 500	2
bx	x-component of model mag. field at satellite, local vertical coord - nT (+70,000.)	F	0.- 140000.0	4

by	y- comp of model field at sat. - nT (+70,000.)	F 0.- 140000.0	4
bz	z- comp of model field at sat. - nT (+70,000.)	F 0.- 140000.0	4
ex	x-component of satellite position unit vector in earth-centered inertial coordinates (+1.)	F 0. - 2.00000	3
ey	y-component of satellite position inertial unit vector (+1.)	F 0. - 2.00000	3
ez	z-component of satellite position inertial unit vector (+1.)	F 0. - 2.00000	3
ssenpot	potential control mode flag vbias (0) or senpot (1)	I 0 - 1	1
svbias	potential difference between s/c and electron probe ground - volts (+10.)	I 7 - 38	1
svip	potential difference between ion array and electron probe ground - volts (+3)	I 0 - 3	1
srepel	drift meter repeller grid functions (dm status)	I 0 - 16	1
sifree	scintillation meter filter range commands	I 0 - 16	1

TOTAL FOR GROUP = 71

DRIFTMETER GROUP OF DATA

INTERNAL NAME OF VARIABLE	DESCRIPTION (BIAS)	INTERNAL TYPE	EXPECTED RANGE	NO OF BYTES
ndm	no. of sets of dm outputs for this minute	I	1 - 60	1
	SUB-TOTAL FOR HEADER GROUP =			1
sec	sec of min for 1st dm set - sec	I	0 - 59	1
vx	vertical vel., 1st sample of sec - m/sec (3000.)	F	0 - 600D.	2
vx	vertical vel. - 2nd sample (normal mode); 1st of raw data (H+ mode)	F	"	2
vx	vertical vel. - 3rd sample (normal mode); 2nd of raw data (H+ mode)	F	"	2
vx	vertical vel. - 4th sample (normal mode); 3rd of raw data (H+ mode)	F	"	2
vx	vertical vel. - 5th sample (normal mode); 4th of raw data (H+ mode)	F	"	2
vx	vertical vel. - 6th sample (normal mode); 5th of raw data (H+ mode)	F	"	2
vz	horizontal vel., 1st sample of sec - m/sec (3000.)	F	0 - 600D.	2
vz	horizontal vel. - 2nd sample (normal mode); 7th of raw data (H+ mode)	F	"	2
vz	horizontal vel. - 3rd sample (normal mode); 8th of raw data (H+ mode)	F	"	2
vz	horizontal vel. - 4th sample (normal mode); 9th of raw data (H+ mode)	F	"	2
vz	horizontal vel. - 5th sample (normal mode); 10th of raw data (H+ mode)	F	"	2
vz	horizontal vel. - 6th sample (normal mode); 10th of raw data (H+ mode)	F	"	2
shkp2	housekeeping value - TM word 60 (If shkp2 .LT. 511, then = raw LLA/LLB output. If skhp2 .EQ. 511, then DM is in H+ mode for next 4 sec; use only first horz. & vert. as drifts.) - no units	I	0 - 511	2

svap	measured aperture potential - V (19.)	F 0 - 60.00	2
---	zero fill	-- --	8

SUB-TOTAL FOR 1st SEC = 37

Repeat 37 bytes for 2nd second of minute.

Repeat 37 bytes for 3rd second of minute.

..
..
..

Repeat 37 bytes for ndm-th second of minute.

Zero Fill 37*(60-ndm) bytes.

TOTAL FOR DM GROUP = 2221

****

FORMAT FOR DRIFTMETER RECORD

DESCRIPTION	NO. OF BYTES
Ephemeris for 1st minute of record	71
Driftmeter data for 1st minute of record	2221
Ephemeris for 2nd minute of record	71
Driftmeter data for 2nd minute of record	2221
Ephemeris for 3rd minute of record	71
Driftmeter data for 3rd minute of record	2221
..	..
..	..
..	..
Ephemeris for 10th minute of record	71
Driftmeter data for 10th minute of record	2221

TOTAL FOR DM RECORD 22920

SCINTILLATION METER GROUP OF DATA

INTERNAL NAME OF VARIABLE	DESCRIPTION (BIAS)	INTERNAL TYPE	EXPECTED RANGE	NO OF BYTES
nsm	no. of sets of sm outputs for this minute	I	1 - 60	1
	SUB-TOTAL FOR HEADER GROUP =			1
sec	sec of min for 1st sm set - sec	I	0 - 59	1
power	ALOG10(rms of delta-N) from 1st filter for 1st data set-ALOG10(#/cm**3) (3.)	F	0 - 8.500	2
power	ALOG10(rms of delta-N) from 2nd filter for 1st data set-ALOG10(#/cm**3) (3.)	F	0 - 8.500	2
..	..	..	..	..
..	..	..	..	..
..	..	..	..	..
power	ALOG10(rms of delta-N) from 9th filter for 1st data set-ALOG10(#/cm**3) (3.)	F	0 - 8.500	2
density	one sec avg of ALOG10(density) for 1st data set - ALOG10(#/cm**3)	F	0 - 6.0000	2
rms	variance of one sec avg of ALOG10(density) for 1st data set - ALOG10(#/cm**3)	F	0 - 6.0000	2
---	zero fill	--	--	9
	SUB-TOTAL FOR 1st SEC =			32

Repeat 32 bytes for 2nd second of minute.

Repeat 32 bytes for 3rd second of minute.

..
..
..

Repeat 32 bytes for nsm-th second of minute.

Zero Fill 32*(60-nsm) bytes

TOTAL FOR SM GROUP = 1921

****

FORMAT FOR SCINTILLATION METER RECORD

DESCRIPTION	NO. OF BYTES
Ephemeris for 1st minute of record	71
Scintillation meter data for 1st minute of record	1921
Ephemeris for 2nd minute of record	71
Scintillation meter data for 2nd minute of record	1921
Ephemeris for 3rd minute of record	71
Scintillation meter data for 3rd minute of record	1921
..	..
..	..
..	..
Ephemeris for 10th minute of record	71
Scintillation meter data for 10th minute of record	1921
TOTAL FOR SM RECORD	19920

ELECTRON LANGMUIR PROBE GROUP OF DATA

INTERNAL NAME OF VARIABLE	DESCRIPTION (BIAS)	INTERNAL TYPE	EXPECTED RANGE	NO OF BYTES
nlang	no. of sets of electron outputs for this minute	I	1 - 30	1
stype	flag to indicate type of output created for 1st elec set - 'S' = sweep, 'B' = bias, and 'D' = dwell type	CHAR	83, 66, or 68	1
stype	flag to indicate type of output created for 2nd elec set	CHAR	83, 66, or 68	1
..	..	..	..	..
..	..	..	..	..
..	..	..	..	..
stype	flag to indicate type of output created for 30th elec set	CHAR	83, 66, or 68	1

SUB-TOTAL FOR HEADER GROUP = 31

IF stype = 'S' OR 'B' FOR 1ST SET,
THEN THE NEXT GROUP OF BYTES FOLLOWS:

sec	sec of min for 1st elec set - sec	I	0 - 59	1
smode	langmuir probe mode for 1st elec set - 'A'...'E'	CHAR	65 - 69	1
edens	electron density - #/cm**3 (ALOG10)	F	0. - 6.50	2
phis	spacecraft potential calc. from analysis of elec.current vs. applied voltage - volts (+35.)	F	0. - 45.0	2
ste	electron temperature - deg. K (ALOG10)	F	2.00 - 4.50	2
---	zero fill	--	---	1

SUB-TOTAL FOR ONE SET OF DATA = 9

IF stype = 'D' FOR 1ST SET,
THEN THE NEXT GROUP OF BYTES FOLLOWS:

sec	sec of min for 1st elec set - sec	I	0 - 59	1
smode	langmuir probe mode for 1st elec set - 'A'...'E'	CHAR	65 - 69	1
mean	mean of electron densities for 1st 4 sec of dwell - #/cm**3 (ALOG10)	F	0. - 6.50	2
sdev	standard deviation of electron densities) for 1st 4 sec of dwell - ALOG10(#/cm**3)	F	0. - 6.00	2
---	fill	-	---	3

SUB-TOTAL FOR ONE SET OF DATA = 9

Repeat 9 bytes for 2nd elec set of minute.

Repeat 9 bytes for 3rd elec set of minute.

..

..

..

Repeat 9 bytes for nlang-th elec set of minute.

Zero fill 9* (30-nlang) bytes.

TOTAL FOR ONE MIN OF ELEC GROUP = 301

****

FORMAT FOR ELECTRON LANGMUIR PROBE RECORD

DESCRIPTION	NO. OF BYTES
Ephemeris for 1st minute of record	71
Electron langmuir probe data for 1st minute of record	301
Ephemeris for 2nd minute of record	71
Electron langmuir probe data for 3rd minute of record	301
Ephemeris for 3rd minute of record	71

Electron langmuir probe data for 3rd minute of record	301
..	..
..	..
..	..
Ephemeris for 20th minute of record	71
Electron langmuir probe data for 20th minute of record	301
TOTAL FOR ELEC RECORD	7440

ION RETARDING POTENTIAL ANALYZER (RPA) GROUP OF DATA

INTERNAL NAME OF VARIABLE	DESCRIPTION (BIAS)	INTERNAL TYPE	EXPECTED RANGE	NO OF BYTES
nrpa	no. of sets of rpa outputs for this minute	I	1 - 15	1
	SUB-TOTAL FOR HEADER GROUP =			1
sec	sec of min. for 1st rpa set - sec	I	0 - 59	1
iontemp	ion temperature for 1st rpa set - deg. K (ALOG10)	F	2.00 - 4.50	2
iondrif	downrange component ofion drift velocity - m/sec (3000.)	F	0 - 600D.	2
scpot	spacecraft potential w.r.t. plasma calc. from 1st rpa set - Volts (35.)	F	0. - 45.0	2
nm	number of ion species used by 1st rpa sweep analysis	I	0 - 4	1
ionmass	mass of 1st ion species for 1st rpa sweep - amu	I	1,4,16,99	1
iondens	density of 1st ion species for 1st rpa sweep - #/cm**3 (ALOG10)	F	0. - 6.50	2
..	..	..	..	..
..	..	..	..	..
..	..	..	..	..
ionmass	mass of 4st ion species for 1st rpa sweep - amu	I	1,4,16,99 (0=not used)	1
iondens	density of 4th ion species for 1st rpa sweep - #/cm**3 (ALOG10)	F	0. - 6.50	2
err	error estimate for 1st rpa sweep - #/cm**3 (ALOG10)	F	0. - 6.00	2
densrpa	total ion density based on 18 pts of saturation current - #/cm**3 (ALOG10)	F	0. - 6.50	2
drpasdv	standard deviation 18pts of total ion densities - #/cm**3 (ALOG10)	F	0. - 6.00	2
---	zero fill	--	---	2
	SUB-TOTAL FOR ONE SET OF DATA =			28

Repeat 28 bytes for 2nd rpa set of minute.

Repeat 28 bytes for 3rd rpa of minute.

..

..

..

Repeat 28 bytes for nrpa-th rpa set of minute.

Zero fill 28*(15-nrpa) bytes.

TOTAL FOR RPA GROUP = 421

****

FORMAT FOR ION RPA RECORD

DESCRIPTION	NO. OF BYTES
Ephemeris for 1st minute of record	71
Ion rpa data for 1st minute of record	421
Ephemeris for 2nd minute of record	71
Ion rpa data for 2nd minute of record	421
Ephemeris for 2nd minute of record	71
Ion rpa data for 3rd minute of record	421
..	..
..	..
..	..
Ephemeris for 20th minute of record	71
Ion rpa data for 20th minute of record	421

TOTAL FOR RPA RECORD 9840

MICROPROCESSOR GROUP OF DATA

INTERNAL NAME OF VARIABLE	DESCRIPTION (BIAS)	INTERNAL TYPE	EXPECTED RANGE	NO OF BYTES
nmicro	no. of sets of micro outputs for this minute	I	1 - 15	1
	SUB-TOTAL FOR HEADER GROUP =			1
sec	sec of min. for 1st micro set - sec	I	0 - 59	1
mcplvel	downrange plasma velocity - m/sec (3000.)	I	0 - 600D	2
mcote	0+ temperature - deg K	I	50D - 2500D	2
mchte	H+ temperature - deg K	I	50D - 2500D	2
mcode	ALOG10(O+ density) - #/cm**3	F	0. - 6.50	2
mchde	ALOG10(H+ density) - #/cm**3	F	0. - 6.50	2
mcspoti	potential of plasma w.r.t. RPA ground - Volts (6.)	F	0. - 10.30	2
mcete	1st electron temp - deg K	I	50D - 2500D	2
mcede	1st ALOG10(electron density) - #/cm**3	F	0. - 6.50	2
mcspote	1st potential of plasma w.r.t. s/c ground - Volts (10.)	F	0. - 51.1	2
mcete	2nd (Mode E) electron temp - deg K	I	50D - 2500D	2
mcede	2nd ALOG10(electron density) - #/cm**3	F	0. - 6.50	2
mcspote	2nd potential of plasma w.r.t. s/c ground - Volts (10.)	F	0. - 51.1	2
---	zero fill	--	---	3
	SUB-TOTAL FOR ONE SET OF DATA =			28

Repeat 28 bytes for 2nd microprocessor set of minute.

Repeat 28 bytes for 3rd microprocessor of minute.

..
..
..

Repeat 28 bytes for nmicro-th microprocessor set of minute.

Zero fill 28*(15-nmicro) bytes.

TOTAL FOR MICROPROCESSOR GROUP = 421

****

FORMAT FOR MICROPROCESSOR RECORD

DESCRIPTION	NO. OF BYTES
Ephemeris for 1st minute of record	71
Microprocessor data for 1st min of record	421
Ephemeris for 2nd minute of record	71
Microprocessor data for 2nd min of record	421
Ephemeris for 3rd minute of record	71
Microprocessor data for 3rd min of record	421
..	..
..	..
..	..
Ephemeris for 20th minute of record	71
Microprocessor data for 20th min of record	421
TOTAL FOR MICROPROCESSOR RECORD	9840

SSJ/4 DATA BASE FORMAT - DMSP/F8/F9

TAPE BLOCKING STRUCTURE: There are 3648 CDC (60-bit) words per record. These records contain exactly 10 minutes of flight data plus 8 spare (vacant) words. Each one minute block consists of 364 CDC (60-bit) words. Should less than 60 seconds of data be present on the GWC tape for any minute (due to telemetry dropout or other reasons) the missing seconds are zero filled at the end of the one minute block (i.e. following all of the normal data for the one minute interval). The last 8 words of every record are vacant (zero fill). The last record of data for a day is zero filled as necessary followed by an End of File.

Each 364 word (one minute) group consists of 3 time and ephemeris words, the time bit map, and 60 groups of telemetry readouts from the J/4 detector. Within each group of telemetry readouts, there are 20 (9-bit) electron values followed by 20 (9-bit) ion values.

In the format description, bit 1 represents the MSB of a CDC word and bit 60 represents the LSB.

SSJ/4 DATA BASE RECORD FORMAT:

CDC Wd.	Desc.	Size (bits)	Bits	Definition
1	GLATX10	12	1-12	Geographic Latitude
	GLONX10	12	13-24	Geographic Longitude
	JDAY	12	25-36	Day of year
	IHR	6	37-42	Hour of day
	IMIN	6	43-48	Minute of hour
	ISEC	6	49-54	Second of minute
	IYR(YR-50	6	55-60	Year-50 (e.g. 84=34)
2	IALT	12	1-12	Altitude (KM)
	CLATX10	12	13-24	CGM 110 km geog lat
	CLONG	12	25-36	CGM 110 km geog long
	RMLATx10	12	37-48	Mag. latitude
	RMLONGx10	12	49-60	Mag. longitude
3	MLT	18	1-18	Mag. local time
	Vacant		19-60	Undefined

SSJ/4 DATA BASE FORMAT (continued)

4	Bit map (1=data, 0=no data)	1	1	Flag for second 1
		1	2	" " " 2
		1	3	" " " 3
		1	4	" " " 4
		.	.	.
		.	.	.
		.	.	.
		1	60	" " " 60
5	E4	9	1-9	Channel E4
	E3	9	10-18	E3
	E2	9	19-27	E2
	E1	9	28-36	E1
	E8	9	37-45	E8
	E7	9	46-54	E7
	E6	6	55-60	E6(6MSBS)
6	E6	3	1-3	E6(3LSBS)
	E5	9	4-12	E5
	E12	9	13-21	E12
	E11	9	22-30	E11
	E10	9	31-39	E10
	E9	9	40-48	E9
	E16	9	50-57	E16
	E15	3	58-60	E15(3MSBS)
7	E15	6	1-6	E15(6MSBS)
	E14	9	7-15	E14
	E13	9	16-24	E13
	E20	9	25-33	E20
	E19	9	34-42	E19
	E18	9	43-51	E18
	E17	9	52-60	E17

8-10	First ion spectra (word order same as electrons; bit map same as for electrons).
11-16	J/4 data for next second
17-22	J/4 data for next second
.	.
.	.
.	.
359-364	J/4 data for last second in the one minute frame.
365-728	Repeat order of words 1-364 for 2nd minute.
729-1092	Repeat order of words 1-364 for 3rd minute.
.	.
.	.
.	.
3277-3640	Repeat order of words 1-364 for 10th minute.
3641-3648	Vacant (zero fill)

SSJ-STAR PROCESSED DATA BASE FORMAT

TAPE BLOCKING STRUCTURE:

There are less than or equal to 4000 CDC (60-bit) words per record. Each record contains successive blocks of data (less than or equal to 64 seconds in duration) containing ephemeris information followed by less than or equal to 64 data words. Data missing due to telemetry dropout is simply missing, i.e. it is not filled. The end of the day is flagged by a four word block. The last record of data is followed by an End of File.

In the format description, bit 1 represents the LSB of a CDC word and bit 60 represents the MSB.

SSJ-STAR DATA BASE RECORD FORMAT:

CDC Wd.	Bits	Definition
1	1-60	# words in logical record
2	1-60	N = # words in succeeding data block (less than or equal to 68)
3	41-60	Code #
	21-40	Year
	1-20	Julian day (1-365/366)
4	41-60	Fill
	21-40	Geog. latitude
	1-20	Geog. longitude
5-6	1-60	Ephemeris
7-70	41-60	UT (sec)
	37-40	Dome # (1-4) *
	1-36	NORM A or B 64 sec data block

Words 2-70 repeat for each 64 second block of data contained in the logical record. In the event that there are less than 64 seconds in a block of data, the number of words, N, in that block is adjusted down to reflect the lesser amount.

* Refer below for format of Dosimeter telemetry stream.

DOSIMETER TELEMETRY STREAM FORMAT

The compression counter assignments for the three modes of data output, NORM A, NORM B, and CAL, are detailed in Table B.1. Each channel (dome) has the compression counter assignment shown in Table B.1. The Dosimeter telemetry stream contains one 36-bit data block per second. The breakdown of these 36 bits into mode and channel identification, and into data bits, is shown in Table B.2. The cycling of mode and channel readouts for Normal Mode Data is shown in table B.3. For the CAL mode the only cycling present is from channels 1 to 4, repeated every 4 seconds.

The compression counters for flux are read out completely every four seconds, for all four channels. This is also true for the dose counts in the CAL mode. The dose counts in the Normal Mode require a NORM A and a NORM B readout for the complete ripple plus compression counter output. From Table B.3 it is seen that a complete Norm A output occurs once every 64 seconds, and is followed by 15 NORM B outputs.

TABLE B.1

Compression Counter Assignments for the Data

		Bits read out for mode		
Item	Type Counter	NORM A	NORM B	CAL
P flux	5 x 3	all 8	all 8	-
E flux	4 x 4	all 8	all 8	-
P dose	4 + 4 x 4	m4, m3, E	P, m2, m1	-
E dose	4 + 4 x 4	m4, m3, E	P, m2, m1	-
Star flux	5	all 5	all 5	lowest bit (1)
Upper flux	5 x 3	-	-	all 8
Lower flux	4 x 4	-	-	all 8
Upper dose	8	-	-	all 8
Lower dose	8	-	-	all 8

TABLE B.2

Breakdown of One Basic 36-bit Data Block

Bit*	Meaning	
1	Normal Mode Id -	0 = NORM A MODE 1 = NORM B MODE
2	Calibrate Mode Id. -	0 = NORM A or B MODE 1 = CAL MODE
3	Channel (DOME) Id. -	0 = Channel (DOME) 2,3 or 4 1 = Channel (DOME) 1

NORM A MODE		NORM B MODE		CAL MODE	
Bits (1-3) = 00X		Bits (1-3) = 10X		Bits(1-3) = X1X	
Bits	Meaning	Bits	Meaning	Bits	Meaning
4-7	P Dose,exp	4-5	P Dose,m2,m1	4-11	Upper CAL Dose
8-9	P Dose,m4,m3	6-9	P Dose,Ripple Cntr.	12-19	Lower CAL Dose
10-13	E Dose, exp	10-11	E Dose,m2,m1	20	Star Flux
14-15	E Dose,m4,m3	12-15	E Dose,Ripple Cntr.	21-28	Upper CAL Flux
16-20	Star Flux	16-20	Star Flux	29-36	Lower CAL Flux
21-28	P Flux	21-28	P Flux		
29-36	E Flux	29-36	E Flux		

* Bit 36 is the least significant bit of the 36-bit word.

TABLE B.3

Breakdown of One Complete Cycle of Normal Mode Data

36-bit word number (also-time lapse in seconds)	Data Content of the 36-bit word	Data Sets
1	NORM A - Channel(Dome) 1	
2	NORM A - Channel(Dome) 2	NORM A
3	NORM A - Channel(Dome) 3	
4	NORM A - Channel(Dome) 4	
5	NORM B - Channel(Dome) 1	
6	NORM B - Channel(Dome) 2	NORM B # 1
7	NORM B - Channel(Dome) 3	
8	NORM B - Channel(Dome) 4	
9-12		NORM B # 2
.		.
.		.
.		.
61-64		NORM B # 15

[Cycle repeats starting at 65 with WORD 1]

APPENDIX C - CALIBRATION TABLES

SSJ/4 F6 ELECTRONS
CONVERSION CONSTANTS (1 APRIL 1989)

CH	ENERGY	GF	C-FLUX	C-DIST	C-EFLX	C-NFLX
1	30.180	7.50E-04	1.36E+04	7.23E-35	3.93E+06	1.30E+05
2	20.620	4.90E-04	2.08E+04	1.62E-34	3.47E+06	1.68E+05
3	14.040	4.10E-04	2.49E+04	2.84E-34	1.93E+06	1.37E+05
4	9.580	3.30E-04	3.09E+04	5.17E-34	1.12E+06	1.17E+05
5	6.500	2.70E-04	3.78E+04	9.32E-34	6.34E+05	9.75E+04
6	4.420	2.10E-04	4.86E+04	1.76E-33	3.70E+05	8.38E+04
7	3.050	1.60E-04	6.38E+04	3.35E-33	2.30E+05	7.53E+04
8	2.060	1.30E-04	7.85E+04	6.11E-33	1.33E+05	6.44E+04
9	1.410	9.60E-05	1.06E+05	1.21E-32	8.06E+04	5.72E+04
10	.984	7.60E-05	1.34E+05	2.19E-32	4.83E+04	4.91E+04
11	.992	1.40E-05	7.29E+05	1.18E-31	2.64E+05	2.66E+05
12	.679	1.00E-05	1.02E+06	2.41E-31	1.84E+05	2.70E+05
13	.462	8.00E-06	1.28E+06	4.43E-31	1.07E+05	2.31E+05
14	.317	5.10E-06	2.00E+06	1.01E-30	7.90E+04	2.49E+05
15	.213	3.40E-06	3.00E+06	2.26E-30	5.50E+04	2.58E+05
16	.145	2.00E-06	5.10E+06	5.64E-30	4.18E+04	2.88E+05
17	.100	1.00E-06	1.02E+07	1.64E-29	3.93E+04	3.93E+05
18	.068	5.00E-07	2.04E+07	4.81E-29	3.75E+04	5.51E+05
19	.046	2.00E-07	5.10E+07	1.78E-28	4.22E+04	9.18E+05
20	.032	6.30E-08	1.62E+08	8.11E-28	7.26E+04	2.27E+06

CH	ENERGY	C-EDENS	C-NDENS
1	30.180	4.78E-03	1.58E-04
2	20.620	5.10E-03	2.47E-04
3	14.040	3.44E-03	2.45E-04
4	9.580	2.41E-03	2.52E-04
5	6.500	1.66E-03	2.56E-04
6	4.420	1.18E-03	2.67E-04
7	3.050	8.79E-04	2.88E-04
8	2.060	6.18E-04	3.00E-04
9	1.410	4.54E-04	3.22E-04
10	.984	3.25E-04	3.31E-04
11	.992	1.77E-03	1.79E-03
12	.679	1.49E-03	2.19E-03
13	.462	1.05E-03	2.27E-03
14	.317	9.38E-04	2.96E-03
15	.213	7.96E-04	3.74E-03
16	.145	7.34E-04	5.06E-03
17	.100	8.30E-04	8.30E-03
18	.068	9.61E-04	1.41E-02
19	.046	1.32E-03	2.86E-02
20	.032	2.71E-03	8.47E-02

SSJ/4 F7 ELECTRONS
CONVERSION CONSTANTS (1 APRIL 1989)

CH	ENERGY	GF	C-FLUX	C-DIST	C-EFLX	C-NFLX
1	30.340	5.80E-04	1.76E+04	9.30E-35	5.14E+06	1.69E+05
2	20.710	4.90E-04	2.08E+04	1.61E-34	3.51E+06	1.69E+05
3	14.070	4.10E-04	2.49E+04	2.84E-34	1.95E+06	1.39E+05
4	9.570	3.30E-04	3.09E+04	5.18E-34	1.11E+06	1.16E+05
5	6.570	2.70E-04	3.78E+04	9.22E-34	6.33E+05	9.64E+04
6	4.470	2.10E-04	4.86E+04	1.74E-33	3.82E+05	8.55E+04
7	3.050	1.60E-04	6.38E+04	3.35E-33	2.31E+05	7.56E+04
8	2.100	1.30E-04	7.85E+04	5.99E-33	1.34E+05	6.36E+04
9	1.430	9.60E-05	1.06E+05	1.19E-32	8.47E+04	5.93E+04
10	.985	7.60E-05	1.34E+05	2.19E-32	4.97E+04	5.04E+04
11	.995	3.30E-05	3.09E+05	4.98E-32	1.16E+05	1.16E+05
12	.679	2.50E-05	4.08E+05	9.64E-32	7.39E+04	1.09E+05
13	.462	2.00E-05	5.10E+05	1.77E-31	4.30E+04	9.31E+04
14	.314	1.30E-05	7.85E+05	4.01E-31	3.04E+04	9.69E+04
15	.215	9.10E-06	1.12E+06	8.36E-31	2.01E+04	9.36E+04
16	.147	5.80E-06	1.76E+06	1.92E-30	1.49E+04	1.01E+05
17	.100	3.40E-06	3.00E+06	4.81E-30	1.17E+04	1.17E+05
18	.069	2.00E-06	5.10E+06	1.19E-29	9.33E+03	1.35E+05
19	.047	1.10E-06	9.28E+06	3.16E-29	8.07E+03	1.72E+05
20	.032	5.70E-07	1.79E+07	8.97E-29	8.59E+03	2.69E+05

CH	ENERGY	C-EDENS	C-NDENS
1	30.340	6.24E-03	2.06E-04
2	20.710	5.15E-03	2.49E-04
3	14.070	3.48E-03	2.47E-04
4	9.570	2.40E-03	2.51E-04
5	6.570	1.65E-03	2.51E-04
6	4.470	1.21E-03	2.70E-04
7	3.050	8.82E-04	2.89E-04
8	2.100	6.16E-04	2.93E-04
9	1.430	4.74E-04	3.31E-04
10	.985	3.34E-04	3.40E-04
11	.995	7.74E-04	7.78E-04
12	.679	5.99E-04	8.82E-04
13	.462	4.23E-04	9.16E-04
14	.314	3.63E-04	1.16E-03
15	.215	2.90E-04	1.35E-03
16	.147	2.59E-04	1.76E-03
17	.100	2.47E-04	2.47E-03
18	.069	2.37E-04	3.44E-03
19	.047	2.49E-04	5.29E-03
20	.032	3.21E-04	1.00E-02

SSJ/4 F8 ELECTRONS
CONVERSION CONSTANTS (1 APRIL 1989)

CH	ENERGY	GF	C-FLUX	C-DIST	C-EFLX	C-NFLX
1	31.300	3.26E-04	3.13E+04	1.60E-34	9.99E+06	3.19E+05
2	21.100	2.75E-04	3.71E+04	2.82E-34	6.65E+06	3.15E+05
3	14.300	2.30E-04	4.44E+04	4.97E-34	3.61E+06	2.52E+05
4	9.720	1.85E-04	5.52E+04	9.10E-34	2.06E+06	2.12E+05
5	6.610	1.52E-04	6.71E+04	1.63E-33	1.16E+06	1.75E+05
6	4.500	1.18E-04	8.65E+04	3.08E-33	6.93E+05	1.54E+05
7	3.050	8.99E-05	1.14E+05	5.97E-33	4.21E+05	1.38E+05
8	2.070	7.30E-05	1.40E+05	1.08E-32	2.39E+05	1.15E+05
9	1.400	5.39E-05	1.89E+05	2.17E-32	1.48E+05	1.06E+05
10	.950	4.27E-05	2.39E+05	4.03E-32	8.63E+04	9.08E+04
11	.950	3.20E-05	3.19E+05	5.38E-32	1.15E+05	1.21E+05
12	.640	2.43E-05	4.20E+05	1.05E-31	6.85E+04	1.07E+05
13	.440	1.94E-05	5.26E+05	1.92E-31	3.82E+04	8.68E+04
14	.310	1.26E-05	8.10E+05	4.19E-31	2.89E+04	9.31E+04
15	.210	8.84E-06	1.15E+06	8.81E-31	2.01E+04	9.58E+04
16	.144	5.63E-06	1.81E+06	2.02E-30	1.46E+04	1.01E+05
17	.098	3.30E-06	3.09E+06	5.06E-30	1.15E+04	1.18E+05
18	.068	1.94E-06	5.26E+06	1.24E-29	9.48E+03	1.39E+05
19	.045	1.07E-06	9.54E+06	3.40E-29	7.94E+03	1.76E+05
20	.031	5.53E-07	1.85E+07	9.54E-29	8.01E+03	2.58E+05

CH	ENERGY	C-EDENS	C-NDENS
1	31.300	1.19E-02	3.81E-04
2	21.100	9.69E-03	4.59E-04
3	14.300	6.38E-03	4.46E-04
4	9.720	4.42E-03	4.55E-04
5	6.610	3.01E-03	4.56E-04
6	4.500	2.18E-03	4.85E-04
7	3.050	1.61E-03	5.28E-04
8	2.070	1.11E-03	5.36E-04
9	1.400	8.39E-04	5.99E-04
10	.950	5.92E-04	6.23E-04
11	.950	7.90E-04	8.31E-04
12	.640	5.73E-04	8.95E-04
13	.440	3.85E-04	8.75E-04
14	.310	3.47E-04	1.12E-03
15	.210	2.94E-04	1.40E-03
16	.144	2.57E-04	1.79E-03
17	.098	2.46E-04	2.51E-03
18	.068	2.43E-04	3.57E-03
19	.045	2.50E-04	5.56E-03
20	.031	3.04E-04	9.81E-03

SSJ/4 F9 ELECTRONS
CONVERSION CONSTANTS (1 APRIL 1989)

CH	ENERGY	GF	C-FLUX	C-DIST	C-EFLX	C-NFLX
1	31.300	2.01E-04	5.08E+04	2.60E-34	1.62E+07	5.18E+05
2	21.100	1.70E-04	6.00E+04	4.56E-34	1.08E+07	5.10E+05
3	14.300	1.42E-04	7.19E+04	8.06E-34	5.85E+06	4.09E+05
4	9.720	1.15E-04	8.87E+04	1.46E-33	3.32E+06	3.41E+05
5	6.610	9.37E-05	1.09E+05	2.64E-33	1.88E+06	2.84E+05
6	4.500	7.29E-05	1.40E+05	4.99E-33	1.12E+06	2.49E+05
7	3.050	5.55E-05	1.84E+05	9.66E-33	6.81E+05	2.23E+05
8	2.070	4.51E-05	2.26E+05	1.75E-32	3.86E+05	1.87E+05
9	1.400	3.33E-05	3.06E+05	3.51E-32	2.40E+05	1.72E+05
10	.950	2.64E-05	3.87E+05	6.52E-32	1.40E+05	1.47E+05
11	.950	3.93E-05	2.60E+05	4.38E-32	9.37E+04	9.87E+04
12	.640	2.98E-05	3.42E+05	8.58E-32	5.59E+04	8.73E+04
13	.440	2.38E-05	4.29E+05	1.56E-31	3.11E+04	7.07E+04
14	.310	1.55E-05	6.58E+05	3.40E-31	2.35E+04	7.57E+04
15	.210	1.08E-05	9.45E+05	7.21E-31	1.65E+04	7.84E+04
16	.144	6.90E-06	1.48E+06	1.65E-30	1.19E+04	8.28E+04
17	.098	4.05E-06	2.52E+06	4.12E-30	9.38E+03	9.57E+04
18	.068	2.38E-06	4.29E+06	1.01E-29	7.73E+03	1.14E+05
19	.045	1.31E-06	7.79E+06	2.77E-29	6.48E+03	1.44E+05
20	.031	6.78E-07	1.51E+07	7.78E-29	6.53E+03	2.11E+05

CH	ENERGY	C-EDENS	C-NDENS
1	31.300	1.94E-02	6.19E-04
2	21.100	1.57E-02	7.43E-04
3	14.300	1.03E-02	7.23E-04
4	9.720	7.11E-03	7.32E-04
5	6.610	4.89E-03	7.39E-04
6	4.500	3.53E-03	7.85E-04
7	3.050	2.61E-03	8.55E-04
8	2.070	1.80E-03	8.67E-04
9	1.400	1.36E-03	9.70E-04
10	.950	9.57E-04	1.01E-03
11	.950	6.43E-04	6.77E-04
12	.640	4.67E-04	7.30E-04
13	.440	3.14E-04	7.13E-04
14	.310	2.82E-04	9.09E-04
15	.210	2.40E-04	1.14E-03
16	.144	2.10E-04	1.46E-03
17	.098	2.00E-04	2.04E-03
18	.068	1.98E-04	2.91E-03
19	.045	2.04E-04	4.54E-03
20	.031	2.48E-04	8.00E-03

SSJ/4 F6 IONS

CONVERSION CONSTANTS (1 APRIL 1989)

CH	ENERGY	GF	C-FLUX	C-DIST	C-EFLX	C-NFLX
1	30.180	1.80E-03	5.67E+03	1.01E-28	1.64E+06	5.42E+04
2	20.620	1.20E-03	8.50E+03	2.23E-28	1.41E+06	6.86E+04
3	14.040	8.10E-04	1.26E+04	4.84E-28	9.76E+05	6.95E+04
4	9.580	5.50E-04	1.86E+04	1.05E-27	6.70E+05	6.99E+04
5	6.500	3.80E-04	2.69E+04	2.23E-27	4.50E+05	6.93E+04
6	4.420	2.60E-04	3.92E+04	4.79E-27	2.99E+05	6.77E+04
7	3.050	1.80E-04	5.67E+04	1.00E-26	2.04E+05	6.69E+04
8	2.060	1.20E-04	8.50E+04	2.23E-26	1.44E+05	6.97E+04
9	1.410	8.10E-05	1.26E+05	4.82E-26	9.56E+04	6.78E+04
10	.984	5.60E-05	1.82E+05	1.00E-25	6.55E+04	6.66E+04
11	.992	2.30E-03	4.44E+03	2.41E-27	1.61E+03	1.62E+03
12	.679	1.50E-03	6.80E+03	5.41E-27	1.22E+03	1.80E+03
13	.462	1.40E-03	7.29E+03	8.52E-27	6.09E+02	1.32E+03
14	.317	7.90E-04	1.29E+04	2.20E-26	5.10E+02	1.61E+03
15	.213	5.50E-04	1.86E+04	4.70E-26	3.40E+02	1.60E+03
16	.145	3.70E-04	2.76E+04	1.03E-25	2.26E+02	1.56E+03
17	.100	2.50E-04	4.08E+04	2.20E-25	1.57E+02	1.57E+03
18	.068	1.80E-04	5.67E+04	4.50E-25	1.04E+02	1.53E+03
19	.046	1.20E-04	8.50E+04	9.98E-25	7.04E+01	1.53E+03
20	.032	8.00E-05	1.28E+05	2.15E-24	5.71E+01	1.79E+03

CH	ENERGY	C-EDENS	C-NDENS
1	30.180	8.53E-02	2.83E-03
2	20.620	8.92E-02	4.33E-03
3	14.040	7.46E-02	5.32E-03
4	9.580	6.20E-02	6.47E-03
5	6.500	5.06E-02	7.78E-03
6	4.420	4.08E-02	9.22E-03
7	3.050	3.35E-02	1.10E-02
8	2.060	2.87E-02	1.39E-02
9	1.410	2.30E-02	1.63E-02
10	.984	1.89E-02	1.92E-02
11	.992	4.63E-04	4.66E-04
12	.679	4.25E-04	6.27E-04
13	.462	2.57E-04	5.56E-04
14	.317	2.59E-04	8.18E-04
15	.213	2.11E-04	9.90E-04
16	.145	1.70E-04	1.17E-03
17	.100	1.42E-04	1.42E-03
18	.068	1.14E-04	1.68E-03
19	.046	9.40E-05	2.04E-03
20	.032	9.15E-05	2.86E-03

SSJ/4 F7 IONS
CONVERSION CONSTANTS (1 APRIL 1989)

CH	ENERGY	GF	C-FLUX	C-DIST	C-EFLX	C-NFLX
1	30.340	2.40E-03	4.25E+03	7.57E-29	1.24E+06	4.09E+04
2	20.710	1.60E-03	6.38E+03	1.66E-28	1.07E+06	5.19E+04
3	14.070	1.10E-03	9.28E+03	3.56E-28	7.27E+05	5.17E+04
4	9.570	7.50E-04	1.36E+04	7.68E-28	4.88E+05	5.10E+04
5	6.570	5.20E-04	1.96E+04	1.61E-27	3.29E+05	5.00E+04
6	4.470	3.50E-04	2.92E+04	3.52E-27	2.29E+05	5.13E+04
7	3.050	2.40E-04	4.25E+04	7.53E-27	1.54E+05	5.04E+04
8	2.100	1.70E-04	6.00E+04	1.54E-26	1.02E+05	4.86E+04
9	1.430	1.10E-04	9.28E+04	3.50E-26	7.40E+04	5.17E+04
10	.985	7.60E-05	1.34E+05	7.36E-26	4.97E+04	5.04E+04
11	.995	2.10E-03	4.86E+03	2.64E-27	1.82E+03	1.82E+03
12	.679	1.40E-03	7.29E+03	5.80E-27	1.32E+03	1.94E+03
13	.462	9.80E-04	1.04E+04	1.22E-26	8.78E+02	1.90E+03
14	.314	6.60E-04	1.55E+04	2.66E-26	6.00E+02	1.91E+03
15	.215	4.60E-04	2.22E+04	5.57E-26	3.98E+02	1.85E+03
16	.147	3.10E-04	3.29E+04	1.21E-25	2.78E+02	1.89E+03
17	.100	2.10E-04	4.86E+04	2.62E-25	1.90E+02	1.90E+03
18	.069	1.50E-04	6.80E+04	5.32E-25	1.24E+02	1.80E+03
19	.047	1.00E-04	1.02E+05	1.17E-24	8.87E+01	1.89E+03
20	.032	7.00E-05	1.46E+05	2.46E-24	7.00E+01	2.19E+03

CH	ENERGY	C-EDENS	C-NDENS
1	30.340	6.46E-02	2.13E-03
2	20.710	6.76E-02	3.27E-03
3	14.070	5.55E-02	3.95E-03
4	9.570	4.52E-02	4.72E-03
5	6.570	3.67E-02	5.59E-03
6	4.470	3.11E-02	6.95E-03
7	3.050	2.52E-02	8.26E-03
8	2.100	2.02E-02	9.61E-03
9	1.430	1.77E-02	1.24E-02
10	.985	1.43E-02	1.45E-02
11	.995	5.21E-04	5.24E-04
12	.679	4.58E-04	6.75E-04
13	.462	3.70E-04	8.01E-04
14	.314	3.06E-04	9.76E-04
15	.215	2.46E-04	1.14E-03
16	.147	2.08E-04	1.41E-03
17	.100	1.72E-04	1.72E-03
18	.069	1.36E-04	1.97E-03
19	.047	1.17E-04	2.49E-03
20	.032	1.12E-04	3.50E-03

SSJ/4 F8 IONS
CONVERSION CONSTANTS (1 APRIL 1989)

CH	ENERGY	GF	C-FLUX	C-DIST	C-EFLX	C-NFLX
1	31.300	1.15E-03	8.87E+03	1.53E-28	2.83E+06	9.05E+04
2	21.100	7.69E-04	1.33E+04	3.40E-28	2.38E+06	1.13E+05
3	14.300	5.29E-04	1.93E+04	7.28E-28	1.57E+06	1.10E+05
4	9.720	3.61E-04	2.83E+04	1.57E-27	1.06E+06	1.09E+05
5	6.610	2.50E-04	4.08E+04	3.33E-27	7.04E+05	1.07E+05
6	4.500	1.68E-04	6.07E+04	7.29E-27	4.87E+05	1.08E+05
7	3.050	1.15E-04	8.87E+04	1.57E-26	3.29E+05	1.08E+05
8	2.070	8.17E-05	1.25E+05	3.26E-26	2.13E+05	1.03E+05
9	1.400	5.29E-05	1.93E+05	7.44E-26	1.51E+05	1.08E+05
10	.950	3.65E-05	2.80E+05	1.59E-25	1.01E+05	1.06E+05
11	.950	1.11E-03	9.19E+03	5.22E-27	3.32E+03	3.49E+03
12	.640	7.41E-04	1.38E+04	1.16E-26	2.25E+03	3.51E+03
13	.440	5.19E-04	1.97E+04	2.41E-26	1.43E+03	3.24E+03
14	.310	3.49E-04	2.92E+04	5.09E-26	1.04E+03	3.36E+03
15	.210	2.43E-04	4.20E+04	1.08E-25	7.32E+02	3.49E+03
16	.144	1.64E-04	6.22E+04	2.33E-25	5.02E+02	3.48E+03
17	.098	1.11E-04	9.19E+04	5.06E-25	3.42E+02	3.49E+03
18	.068	7.94E-05	1.29E+05	1.02E-24	2.32E+02	3.41E+03
19	.045	5.29E-05	1.93E+05	2.31E-24	1.61E+02	3.57E+03
20	.031	3.70E-05	2.76E+05	4.80E-24	1.20E+02	3.86E+03

CH	ENERGY	C-EDENS	C-NDENS
1	31.300	1.45E-01	4.63E-03
2	21.100	1.48E-01	7.03E-03
3	14.300	1.19E-01	8.31E-03
4	9.720	9.70E-02	9.98E-03
5	6.610	7.84E-02	1.19E-02
6	4.500	6.57E-02	1.46E-02
7	3.050	5.39E-02	1.77E-02
8	2.070	4.25E-02	2.05E-02
9	1.400	3.66E-02	2.61E-02
10	.950	2.97E-02	3.12E-02
11	.950	9.75E-04	1.03E-03
12	.640	8.05E-04	1.26E-03
13	.440	6.16E-04	1.40E-03
14	.310	5.36E-04	1.73E-03
15	.210	4.57E-04	2.18E-03
16	.144	3.79E-04	2.63E-03
17	.098	3.13E-04	3.20E-03
18	.068	2.54E-04	3.74E-03
19	.045	2.17E-04	4.82E-03
20	.031	1.95E-04	6.28E-03

SSJ/4 F9 IONS

CONVERSION CONSTANTS (1 APRIL 1989)

CH	ENERGY	GF	C-FLUX	C-DIST	C-EFLX	C-NFLX
1	31.300	1.14E-03	8.95E+03	1.54E-28	2.86E+06	9.13E+04
2	21.100	7.62E-04	1.34E+04	3.43E-28	2.40E+06	1.14E+05
3	14.300	5.24E-04	1.95E+04	7.35E-28	1.58E+06	1.11E+05
4	9.720	3.57E-04	2.86E+04	1.59E-27	1.07E+06	1.10E+05
5	6.610	2.48E-04	4.11E+04	3.36E-27	7.10E+05	1.07E+05
6	4.500	1.67E-04	6.11E+04	7.33E-27	4.89E+05	1.09E+05
7	3.050	1.14E-04	8.95E+04	1.58E-26	3.32E+05	1.09E+05
8	2.070	8.10E-05	1.26E+05	3.29E-26	2.15E+05	1.04E+05
9	1.400	5.24E-05	1.95E+05	7.51E-26	1.53E+05	1.09E+05
10	.950	3.62E-05	2.82E+05	1.60E-25	1.02E+05	1.07E+05
11	.950	1.30E-03	7.85E+03	4.46E-27	2.83E+03	2.98E+03
12	.640	8.64E-04	1.18E+04	9.96E-27	1.93E+03	3.01E+03
13	.440	6.05E-04	1.69E+04	2.07E-26	1.22E+03	2.78E+03
14	.310	4.07E-04	2.51E+04	4.37E-26	8.94E+02	2.88E+03
15	.210	2.84E-04	3.59E+04	9.24E-26	6.26E+02	2.98E+03
16	.144	1.91E-04	5.34E+04	2.00E-25	4.31E+02	2.99E+03
17	.098	1.30E-04	7.85E+04	4.32E-25	2.92E+02	2.98E+03
18	.068	9.26E-05	1.10E+05	8.75E-25	1.99E+02	2.92E+03
19	.045	6.17E-05	1.65E+05	1.98E-24	1.38E+02	3.06E+03
20	.031	4.32E-05	2.36E+05	4.11E-24	1.03E+02	3.31E+03

CH	ENERGY	C-EDENS	C-NDENS
1	31.300	1.46E-01	4.67E-03
2	21.100	1.50E-01	7.10E-03
3	14.300	1.20E-01	8.39E-03
4	9.720	9.81E-02	1.01E-02
5	6.610	7.91E-02	1.20E-02
6	4.500	6.61E-02	1.47E-02
7	3.050	5.44E-02	1.78E-02
8	2.070	4.28E-02	2.07E-02
9	1.400	3.70E-02	2.64E-02
10	.950	2.99E-02	3.15E-02
11	.950	8.33E-04	8.76E-04
12	.640	6.90E-04	1.08E-03
13	.440	5.29E-04	1.20E-03
14	.310	4.60E-04	1.48E-03
15	.210	3.91E-04	1.86E-03
16	.144	3.25E-04	2.26E-03
17	.098	2.67E-04	2.73E-03
18	.068	2.18E-04	3.21E-03
19	.045	1.86E-04	4.13E-03
20	.031	1.67E-04	5.38E-03